

highly crystalline body (I speak of the iodide *alone*, not of the alloy) into a transparent, plastic, denser body. What the precise function of the molecular motion which disappears can be it is difficult to assume, since in this case it not only changes the state of the body, but approximates its molecules.

Of the texture, specific gravity, &c. of the alloys.—It is noticeable that when the percentage of iodide of silver is small, the alloy is brittle while hot, and only slightly more tenacious than its constituents when cold (No. 1); as the percentage of iodide increases, the alloy becomes somewhat less brittle while hot, and considerably more tenacious, hard, and compact, than any of its constituents (Nos. 2 & 3); while when the percentage of iodide becomes considerable (Nos. 4 & 5), the mass becomes extremely plastic while hot, perhaps more so than the iodide itself, and very brittle when cold. The specific gravity is in all cases *above* the mean of that of the constituents; it may be because the intercrystalline spaces of the iodide are now filled with bromide and chloride. Thus, while the sp. gr. of Ag Cl is 5.505, of Ag Br 6.245, and of Ag I 5.675, that of the alloys is as follows:—No. 1, 6.152; No. 2, 6.1197; No. 3, 6.503; No. 4, 5.9717; and No. 5, 5.907: while the percentage of the bromide, which alone has a higher specific gravity than that of the alloys, in no case exceeds 42.

In the accompanying curve table (p. 300) the expansion-curves of the iodide and bromide of silver have been added for comparison with those of the alloys; the curve of chloride of silver has been omitted, because it is almost precisely the same as that of the bromide.

I have preferred to call these results “approximate” on account of certain experimental difficulties in the way of very precise determinations, which difficulties I at present see no way of avoiding.

November 16, 1876.

Dr. J. DALTON HOOKER, C.B., President, in the Chair.

In pursuance of the Statutes, notice of the ensuing Anniversary Meeting was given from the Chair.

Dr. Henry Edward Armstrong and Capt. George Strong Nares were admitted into the Society.

Prof. W. G. Adams, Mr. Bramwell, Mr. Busk, Dr. Russell, and General
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Smythe, having been nominated by the President, were elected by ballot Auditors of the Treasurer's Accounts on the part of the Society.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read :—

- I. “Experimental Contributions to the Theory of the Radiometer.”—Preliminary Notice. By WILLIAM CROOKES, F.R.S. &c. Received November 15, 1876.

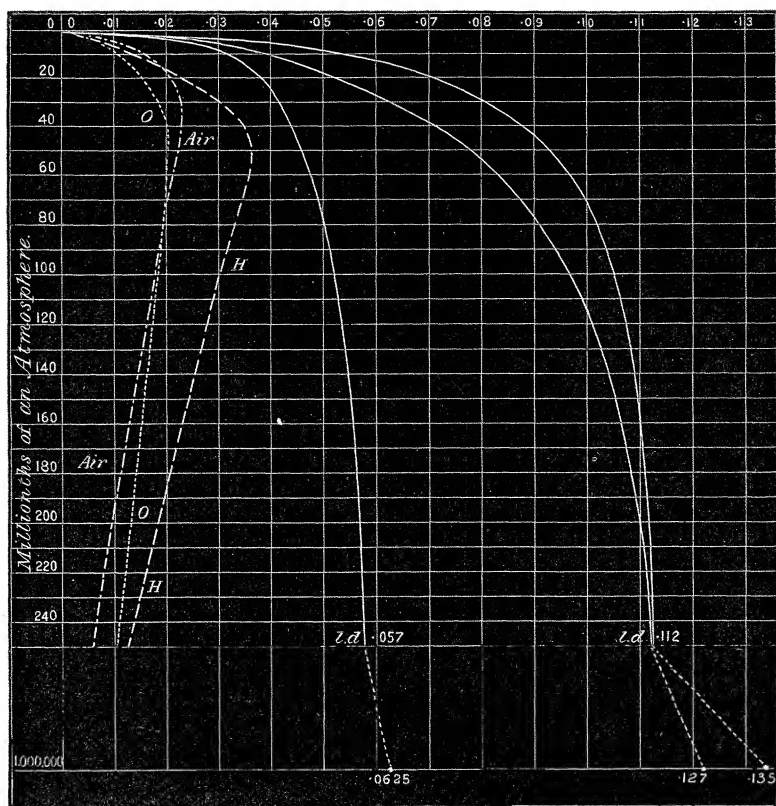
Instead of bringing another preliminary notice before the Society, I should have preferred reserving the announcement of my new results on the Repulsion resulting from Radiation until they were fit to be offered in a more complete form ; but the radiometer is now so much occupying the attention of scientific men, and results of experiments with this and allied instruments are appearing so frequently in the scientific journals at home and abroad, that were I not to adopt this method of bringing the results of my more recent experiments before men of science, I might find myself anticipated in some or all of the conclusions at which I have arrived.

On June 15th last I mentioned to the Society that the repulsion resulting from radiation increases up to a certain point as I exhaust the air from the torsion-apparatus. After long-continued exhaustion the force of radiation approaches a maximum, and then begins to fall off. I have since succeeded in experimenting at still higher exhaustions, and with different gases in the apparatus ; and by means of a McLeod gauge attached to the mercury pump I have been able to measure the atmospheric pressure at any desired stage of exhaustion. I have not only measured the force of repulsion, but also the viscosity of the residual gas ; and from the results I have plotted the observations in curves which accompany this paper, and which show how the viscosity of the residual gas is related to the force of repulsion exerted by radiation. These curves must not, however, be considered as representing more than the broad facts, for I have not included in them my final observations, which in all probability will introduce modifications in them.

In plotting these curves I have supposed my scale to be 1000 metres long, and to represent one atmosphere. Halfway up the scale therefore, or 500 metres, represents half an atmosphere ; 999 metres up the scale represents an exhaustion of $\frac{1}{1000}$ of an atmosphere : each millimetre, therefore, stands for the millionth of an atmosphere.

My results have principally been obtained at the top of the scale ; and it is the last quarter of a metre which supplies the diagrams accompanying this paper.

When the residual gas is air, the viscosity (measured by the logarithmic decrement of the arc of oscillation) is practically constant up to an exhaustion of 250 millionths of an atmosphere, or 0.19 millim. of mercury, having only diminished from 0.126 at the normal pressure of the atmosphere to 0.112. It now begins to fall off: at 200 millionths it is 0.110, at 100 millionths it is 0.096, at 50 millionths it is 0.078, at 20 millionths it is 0.052, at 10 millionths it is 0.035, and at 0.1 of a millionth of an



atmosphere the log. dec. has fallen to about 0.01. Simultaneously with this decrease in the viscosity, the force of repulsion exerted on a black surface by a standard light varies. It increases very slowly till the exhaustion has risen to about 70 millionths of an atmosphere; at about 40 millionths the force is at its maximum; and it then sinks very rapidly, till at 0.1 millionth of an atmosphere it is less than one tenth of its maximum. On continuing the curves of the log. dec. and the force of radiation, and assuming that the torsion-fibre of glass has no viscosity, it is most probable that

they both would come to zero when the last traces of an atmosphere had been taken out of the apparatus.

The oxygen diagram differs from that of air. The log. dec. is 0.126 at the atmospheric pressure; it falls to 0.111 at a pressure of 250 millionths of an atmosphere; at 100 millionths it is 0.105, at 50 millionths it is 0.093, at 20 millionths it is 0.068, and at 2 millionths it is 0.02. The force of repulsion in oxygen increases very steadily up to an exhaustion of about 40 millionths of an atmosphere; it is at its maximum at about 30 millionths, and thence declines very rapidly.

Hydrogen gives a remarkable diagram. The viscosity at the normal pressure is measured by a log. dec. of 0.063; at 250 millionths of an atmosphere it is 0.057, at 100 millionths it is 0.052, at 50 millionths it is 0.046, whence it rapidly sinks. The force of repulsion increases slowly up to an exhaustion of 250 millionths, then quickly until it attains its maximum at about 50 millionths, and it then rapidly declines. The force of repulsion is very great in a hydrogen vacuum, being in comparison with the maximum in an air vacuum as 70 to 41. Neither is it necessary to get so high an exhaustion with hydrogen as with other gases to obtain considerable repulsion. This shows that in the construction of radiometers it is advantageous to fill them with hydrogen before exhausting.

Carbonic acid has a viscosity of about .01 at the normal pressure, being between air and hydrogen, but nearer the former. On approaching a vacuum, the force of repulsion does not rise very high, and soon falls off.

Before working with this apparatus I thought that monohydrated sulphuric acid evolved no vapour, and I therefore freely used it for cleaning out the pump and for drying the gases. I can even now detect no vapour-tension; but a comparison of the curves, with and without sulphuric acid, shows that the presence of this body modifies the results. One of my curves represents the action of the residual sulphuric anhydride gas. The experience thus gained has led me to adopt phosphoric anhydride for drying the gases. I can detect no ill effects from the presence of this agent; and I have been able in consequence to push the rarefaction to higher points than before.

The McLeod gauge will not show the presence of mercury vapour. It is therefore possible that I have a greater pressure in the apparatus than is here stated. I have, however, entirely failed to detect the presence of mercury vapour at any great distance from the mercury in the pump; and the tube packed with gold-leaf, which I frequently interpose between the pump and the apparatus, shows no trace of bleaching, and exerts no appreciable effect one way or the other on the results.

With this pump, assisted sometimes by chemical absorption, it is not

difficult to exhaust a radiometer to such a point that it will not move to a candle placed a few inches off; but I have not yet succeeded in stopping the movement of the beam in the torsion-apparatus.

A long series of observations have been taken, at different degrees of exhaustion, on the conductivity of the residual gas to the spark from an induction-coil. Working with air, I find that at a pressure of about 40 millionths of an atmosphere, when the repulsive force is near its maximum, a spark, whose striking distance at the normal pressure is half an inch, will illuminate a tube having aluminium terminals 3 millimetres apart. When I push the exhaustion further, the $\frac{1}{2}$ -inch spark ceases to pass; but a 1-inch spark will still illuminate the tube. As I get nearer to a vacuum more power is required to drive the spark through the tube; but at the highest exhaustions I can still get indications of conductivity when an induction-coil actuated with five Grove's cells, and capable of giving a 6-inch spark, is used.

When so powerful a spark is employed there is great danger of perforating the glass, thus causing a very slight leakage of air into the apparatus. The log. dec. now slowly rises, the repulsive force of the candle increases to its maximum, and then slowly diminishes to zero, the log. dec. continuing to rise till it shows that the internal and external pressures are identical. With a fine perforation several days are occupied in going through these phases, and they take place with such slowness and regularity as to afford opportunities for getting valuable observations.

The improvements now added by Mr. Gimmingham to the pump render it so easy to obtain high exhaustions that, in preparing experimental radiometers, I prefer to exhaust direct to one or two millionths of an atmosphere. By keeping the apparatus during this exhaustion in a hot-air bath heated to about 300° C. for some hours, the occluded gases are driven off from the interior surface of the glass and the fly of the radiometer. The whole is then allowed to cool, and attenuated air from the air-trap is put in in small quantities at a time, until the McLeod gauge shows that the best exhaustion for sensitiveness is reached; if necessary, this point is also ascertained by testing with a candle. Working in this way, I can now do in a few hours what formerly required as many days. In this manner, employing hydrogen instead of air for the gaseous residue, and using roasted mica vanes set at an angle with the axis, as described further on, I can get very considerably increased sensitiveness in radiometers. I am still unable, however, to get them to move in moonlight. The statements made by an observer nearly a year ago, that he obtained strong rotation by moonlight, must therefore be considered erroneous. My most sensitive torsion-balance will, however, move easily to moonlight.

The above-mentioned facts, in addition to what has already been pub-

lished, leave no reasonable doubt that the presence of residual gas* is the cause of the movement of the radiometer. But few theories are sufficiently strong not to require reinforcement; and in the present case very much remains to be ascertained as regards the mode of action of the residual gas. The explanation, as given by Mr. Johnstone Stoney, appears to me the most probable; and having stood almost every experimental test to which I have submitted it, I may assume for the present that it expresses the truth. According to this the repulsion is due to the internal movements of the molecules of the residual gas. When the mean length of path between successive collisions of the molecules is small compared with the dimensions of the vessel, the molecules rebounding from the heated surface, and therefore moving with an extra velocity, help to keep back the more slowly moving molecules which are advancing towards the heated surface; it thus happens that though the individual kicks against the heated surface are increased in strength in consequence of the heating, yet the number of molecules struck is diminished in the same proportion, so that there is equilibrium on the two sides of the disk, even though the temperatures of the faces are unequal. But when the exhaustion is carried to so high a point that the molecules are sufficiently few and the mean length of path between their successive collisions is comparable with the dimensions of the vessel, the swiftly moving, rebounding molecules spend their force, in part or in whole, on the sides of the vessel, and the onward crowding, more slowly moving molecules are not kept back as before, so that the number which strike the warmer face approaches to, and in the limit equals, the number which strike the back, cooler face; and as the individual impacts are stronger on the warmer than on the cooler face, pressure is produced, causing the warmer face to retreat.

I have tried many experiments with the view of putting this theory to a decisive test. The repulsive force being due to a reaction between the fly and the glass case of a radiometer, it follows that, other things being equal, the fly should revolve faster in a small bulb than in a large one. This cannot well be tested with two different radiometers, as the weight of the fly and the amount of friction would not be the same in each; but I have constructed a double radiometer which shows this fact in a very satisfactory manner. It consists of two bulbs, one large and the other small, blown together so as to have a wide passage between them. In the centre of each bulb is a cup, held in its place by a glass rod, and in

* It is a question whether the residual gas in the apparatus, when so highly attenuated as to have lost the greater part of its viscosity, and to be capable of acquiring molecular movement palpable enough to overcome the inertia of a plate of metal, should not be considered to have got beyond the gaseous state, and to have assumed a fourth state of matter, in which its properties are as far removed from those of a gas as this is from a liquid.

the bulbs is a small four-armed fly with roasted mica disks blacked on one side. The fly can be balanced on either cup. In the smaller bulb there is about a quarter of an inch between the vanes and the glass, whilst in the larger cup there is a space of half an inch. The mean of several experiments shows that in the small bulb the fly rotates about 50 per cent. faster than in the large bulb, when exposed to the same source of light.

One of the arms of another radiometer was furnished with roasted mica disks blacked on alternate sides. The other arm was furnished with clear mica disks. The two arms were pivoted independently of each other, and one of them was furnished with a minute fragment of iron, so that by means of a magnet I could bring the arms in contact, the black surface of the mica then having a clear plate of mica in front of it. On bringing a lighted candle near the instrument, and allowing it to shine through the clear plate on the blackened mica, the clear plate is at once driven away till the arm sets at right angles to the other.

Two currents of force, acting in opposite directions, can exist in the same bulb. I have prepared a double radiometer in which two flies are pivoted one over the other, and having their blackened sides turned in opposite directions. On bringing a lighted candle near, the flies rapidly rotate in opposite directions.

Experiment shows that the force can be reflected from a plane surface in such a manner as to change its direction. If an ordinary radiometer is exposed to light the black surface is repelled, owing to the excess of pressure acting between it and the glass. If, however, a plate of mica were to arrest this force and reflect it back again, the motion should be reversed. Experiment shows that this is the case. A two-disk radiometer was made, having flat opaque mica disks blacked on one side. In front of the black surface of the mica, about a millimetre off, is fixed a large disk of thin clear mica. On bringing a candle near, the molecular pressure streaming from the black surface is caught by the clear plate and thrown back again, causing pressure behind instead of in front; and the result is rapid rotation in the negative direction, the black side now moving towards the light.

To still further test this view of the action, I made another radiometer, similar to the above, but having a clear mica disk on each side of the ordinary mica vane. This prevents the reflection of the pressure backwards, and causes it to expend itself in a vertical plane, the result being an almost total loss of sensitiveness.

The above actions can be explained on the "evaporation and condensation" theory, as well as by that of molecular movement; and I therefore devised the following test to decide between these two theories. A radiometer has its four disks cut out of very clear and thin plates of mica, and these are mounted in a somewhat large bulb. At the

side of the bulb, in a vertical plane, a plate of mica, blacked on one side, is fastened in such a position that each clear vane in rotating shall pass it, leaving a space between of about a millimetre. If a candle is brought near, and by means of a shade the light is allowed to fall only on the clear vanes, no motion is produced; but if the light shines on the black plate, the fly instantly rotates as if a wind were issuing from this surface, and keeps on moving as long as the light is near. This could not happen on the evaporation and condensation theory, as this requires that the light should shine intermittently on the black surface in order to keep up continuous movement.

By cutting a thin plate of aluminium into the form of a spiral, then drawing it out corkscrew fashion, blacking the upper surface and suspending it on a point, a spiral radiometer is made, which rotates like a screw on exposure to light. Here also the black surface need never be in darkness, the pressure acting continuously between the black side of the spiral and the cylindrical tube in which it is mounted.

The experiments with the double radiometer of different sizes showed that the nearer the absorbing surface was to the glass, the greater was the pressure produced. To test this point in a more accurate manner, a torsion-balance was fitted up with a glass suspending fibre and reflecting mirror, as described in my previous papers. At one end of the beam is a disk of roasted mica blacked on one side. In front of this black surface, and parallel to it, is a plate of clear mica, so arranged that its distance from the black surface can be altered as desired, at any degree of exhaustion, without interfering with the vacuum. This apparatus is very sensitive and gives good quantitative results. It has proved that when light falls on the black surface molecular pressure is set up, whatever be the degree of exhaustion. At the atmospheric pressure this disturbance can only be detected when the mica screen is brought close to the black surface, and it is inappreciable when the screen is moved away. As the barometer-gauge rises, the thickness of the layer of disturbance increases. Thus, retaining the standard candle always the same distance off, when the gauge is at 660 millims., the molecular pressure is represented by 1 when the space separating the screen from the black surface is 3 millims., by 3 when the intervening space is reduced to 2 millims., and by 5 when the space is 1 millim. With the gauge 722 millims. high, the values of the molecular pressure for the spaces of 3, 2, and 1 millim. are respectively 3, 7, and 12. When the gauge is at 740 millims., the corresponding values for spaces of 3, 2, and 1 millim. are 11, 16, and 23. With the gauge at 745 millims., the molecular pressures are represented by 30, 34, and 40, for spaces 3, 2, and 1 millim. When the gauge and barometer are level, the action is so strong that the candle has to be moved double the distance off, and the pressures when the intervening spaces are 12, 6, and 3 millims. are respectively 60, 86,

and 107. A large series of observations have been taken with this apparatus, with the result not only of supplying important data for future consideration, but of clearing up many anomalies which were noticed, and of correcting many errors into which I was led at earlier stages of this research. Among the latter may be mentioned the speculations in which I indulged as to the pressure of sunlight on the earth.

Hitherto most of my experiments had been carried on with bad conductors of heat. To get the maximum action of a radiometer it appeared necessary that no heat should pass through to the back surface, but that all should be kept as much as possible on the surface on which the light fell*. At first I used pith, but since learning the advantage of raising the whole apparatus to a high temperature during exhaustion, I have used roasted mica lampblack on one side for the vanes; for this purpose it is almost perfect, being a good absorber on one face, a good reflector on the other, a bad conductor for heat, extremely light, and able to stand high temperatures. Many experiments have been tried with metal radiometers, some of the results being recorded in previous papers which I have read before the Society; but being less sensitive than pith or mica instruments, I had not hitherto worked much with them. I now tried similar experiments to the above, using the best conductors of heat instead of the worst; and for this purpose thick gold-leaf was selected for the surface on which to try the action of radiation.

An apparatus was constructed resembling a radiometer with an opening at the top, capable of being closed with a plate of glass. Through this I could introduce disks of any substance I liked, mounted in pairs on an aluminium arm rotating on a needle-point. The first disks were of gold-leaf, blacked on alternate sides. After exhaustion, a candle repelled the black surface of one of the disks, but, to my surprise, it strongly attracted the black surface of the other disk. I noticed that the disk which moved the negative way was somewhat crumpled, and had the outer edge curved so as to present a slightly concave black surface to the candle. I soon found that the curvature of the disk was the cause of the anomaly observed, and experiments were then tried with disks of gold and aluminium—the latter being chiefly used as being lighter and stiffer, whilst it acted in other respects as gold.

A radiometer the fly of which is made of perfectly flat aluminium plates, lampblack on one side, is much less sensitive to light than one of mica or pith, but, as I proved in my earlier papers, it is more sensitive to dark heat. Exposed to light, the black face of a metal radiometer moves away as if it were black pith. When, however, it is exposed to dark

* I have already shown that when a ray of *light* from any part of the spectrum falls on a black surface the ray is absorbed and degraded in refrangibility, warming the black surface and being emitted as radiant heat. In this sense only can the repulsion resulting from radiation be called an effect of heat.

heat, either by grasping the bulb with the warm hand, dipping it into hot water, or covering it with a hot glass shade, it rapidly rotates in a negative direction, the black advancing, and continuing to do so until the temperature has become uniform throughout. On now removing the source of heat, the fly commences to revolve with rapidity the positive way, the black this time retreating as it would if light shone on it. Pith or mica radiometers act differently to this, dark heat causing them to revolve in the same direction as light does.

The outer corners of the aluminium plates, which were mounted diamond-wise, were now turned up at an angle of 45° , the lampblackened surface being concave and the bright convex. On being exposed to a candle, scarcely any movement was produced; when one vane was shaded off the other was repelled slightly, but the turned-up corner seemed to have almost entirely neutralized the action of the black surface. A greater amount of the same corner was now turned up, the fold going through the centres of adjacent sides. Decided rotation was now produced by a candle, but the black surface was *attracted** instead of repelled. Dark heat still caused the opposite rotation to light, repelling the black surface.

The plates were now folded across the vertical diagonal, the black surface being still inside and the bright metal outside. The actions with a candle and hot glass shade were similar to the last, but more decided.

The plates were now flattened, and put on the arms at an angle, still being in the vertical plane. When the bright surface was outside, scarcely any action was produced by a candle; but when the lampblackened surface was outside, strong repulsion of the black was produced, both with a candle and with a hot shade.

The square aluminium plates were mounted in the experimental apparatus, one being attached to the arm by the centre of one of the sides, and the other by an angle. The opposite corner of the one mounted diamond-wise was turned up at an angle. The outer convex surface of the diamond plate was blacked, and the side of the square plate facing the same way was also blacked, so that either two black or two bright surfaces were always exposed to the light, instead of a black and a white surface, as is usual in radiometers. As might have been expected, both these black surfaces were repelled; but the turned-up corner of the diamond-mounted plate proved so powerful an auxiliary to its black surface, that strong rotation was kept up, the square plate being dragged round against the action of light.

Folding the plates with the angle horizontal has not so decided an action as when the fold is vertical.

Sloping the plates and disks of a lampblackened mica radiometer so as to

* I use the word attraction in these cases for convenience of expression. I have no doubt that what looks like attraction in these and other cases is really due to *vis a tergo*.

have the black outside, and consequently more facing the side of the bulb, greatly increases its sensitiveness.

The above experiments show that shape has even a stronger influence than colour. A convex bright surface is strongly repelled, whilst a concave black surface is not only not repelled by radiation but is actually attracted.

I have also tried carefully shaped cups of gold, aluminium, and other metals, as well as cones of the same materials. I will briefly describe the behaviour of a few typical radiometers made with metal cups, which I have the honour of exhibiting to the Society.

No. 1035. A two-disk, cup-shaped radiometer, facing opposite ways; both sides bright. The disks are 14·5 millims. diameter, and their radius of curvature is 14 millims.

Exposed to a standard candle 3·5 inches off, the fly rotates continuously at the rate of one revolution in 3·37 seconds. A screen placed in front of the concave side so as to let the light shine only on the convex surface, repels the latter, causing continuous rotation at the rate of one revolution in 7·5 seconds. When the convex side is screened off so as to let the light shine only on the concave side, continuous rotation is produced at the rate of one revolution in 6·95 seconds, the concave side being attracted.

These experiments show that the repulsive action of radiation on the convex side is about equal to the attractive action of radiation on the concave side, and that the double speed with which the fly moves when no screen is interposed is the sum of the attractive and repulsive actions.

No. 1037. A two-disk, cup-shaped aluminium radiometer, as above, lamblackened on the concave surfaces.

In this instrument the action of light is reversed, rotation taking place, the bright convex side being repelled, and the black concave attracted.

That this attraction is not apparent only, is proved by shading off the sides one after the other. When the light shines only on the bright convex side no movement is produced, but when it shines on the black concave side, this is attracted, producing rotation.

No. 1038. A cup-shaped radiometer similar to the above, but having the convex surfaces black and the concave bright.

Light shining on this instrument causes it to rotate rapidly, the convex black being repelled. No movement is produced on letting the light shine on the bright concave surface, but good rotation is produced when only the black convex surface is illuminated.

No. 1039. A cup-shaped radiometer like the above, but blacked on both sides.

With this a candle causes rapid rotation, the convex side being repelled. On shading off the light from the concave side the rotation continues, but much more slowly; on shading off the convex side the concave is strongly attracted, causing rotation.

When either of these four radiometers is heated by a hot shade or plunged into hot water, rotation is always produced in the opposite direction to that caused by the light. On removing the source of heat the motion rapidly stops, and then commences in the opposite direction (*i. e.* as it would rotate under the influence of light), the rotation continuing as long as the fly is cooling. Chilling one of these radiometers with ether has the opposite action to exposing it to dark heat.

The vanes of radiometers have also been formed of metal cones, and of cups and cones of plain mica, roasted mica, pith, paper, &c. ; and they have been used either plain or blacked on one or both surfaces. These have also been balanced against each other, and against metal plates, cups, and cones. The results are of considerable interest, but too complicated to explain without great expenditure of time and numerous diagrams. The broad facts are contained in the above selections from my experiments.

The action of light on the cup-shaped vanes of a radiometer probably requires more experimental investigation before it can be properly understood. Some of the phenomena may be explained on the assumption that the molecular pressure acts chiefly in a direction normal to the surface of the vanes. A convex surface would therefore cause greater pressure to be exerted between itself and the bounding surface of glass than would a concave surface. In this way the behaviour of the cup-shaped radiometer with both surfaces bright, No. 1035, can be understood, and perhaps also that of Nos. 1038 and 1039. It would not be difficult to test this view experimentally, by placing a small mica screen in the focus of a concave cup where the molecular force should be concentrated. But it is not easy to see how such an hypothesis can explain the behaviour of No. 1037, where the action of the bright convex surface more than overcomes the superior absorptive and radiating power of the concave black surface; and the explanation entirely fails to account for the powerful attraction which a lighted candle is seen to exert on the concave surfaces in Nos. 1035, 1037, and 1039.

II. "Magnetic Observations made at Stonyhurst College Observatory from April 1870 to March 1876." By the Rev. S. J. PERRY, S.J., F.R.S. Received July 31, 1876.

A double series of magnetic observations are being carried on continuously at this Observatory. The monthly determinations of the absolute elements date from the year 1863, but the uninterrupted photographic record of the variations of the Declination and of the components of the Intensity was only commenced in 1867. The photographic curves of the Declination and Horizontal Force have all been measured, and are in course of reduction; and the Vertical-Force curves will soon be taken in hand. The results of the first seven years' observations of the Dip and Horizontal Force appeared in the Philosophical Transactions for 1871, and the

